Designing the VCNL3036 Into an Application

By Reinhard Schaar

INTRODUCTION AND BASIC OPERATION

The VCNL3036 integrates a biosensor (BIO), mux, and driver for up to three external IREDs / LEDs in one small package. It incorporates photodiode, amplifier, and analog to digital converting circuits into a single chip by a CMOS process. The BIO comes with a programmable interrupt feature with individual high and low thresholds to offer the best utilization of resources and power savings on the microcontroller.

The BIO features an intelligent cancellation scheme, so that the cross talk phenomenon is effectively eliminated. To accelerate the BIO response time, smart persistence prevents the misjudgement of proximity sensing, but also keeps a fast response time. An active force mode, one-time trigger by one instruction, is another good approach for more design flexibility when fulfilling different kinds of applications with more power savings.

The VCNL3036 provides an excellent temperature compensation capability for keeping the output stable under various temperature configurations. The BIO functions are easily operated via the simple command format of the I^{2}C (SMBus-compatible) interface protocol. Operating voltages range from 2.5 V to 3.6 V. The VCNL3036 is packaged in a lead (Pb)-free, 8-pin QFN package, which offers the best market-proven reliability.

Fig. 1 - VCNL3036 Top View

COMPONENTS (BLOCK DIAGRAM)

The major components of the VCNL3036 are shown in the block diagram below.

In addition to the ASIC with the ambient light and proximity photodiode, the “switch” for up to three external emitters is also implemented.

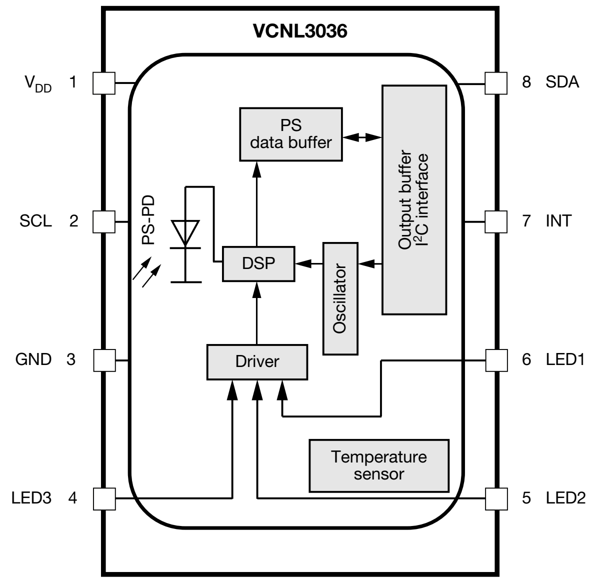

Fig. 2 - VCNL3036 Detailed Block Diagram

External LED(s) with every wavelength between 500 nm and 940 nm may be used, as the spectral sensitivity of the detector is quite wide.

The ASIC has a programmable drive current from 5 mA to 200 mA in eight steps, plus a factor 10 divider. The light is emitted in short pulses with a programmable duty ratio from 1/40 to 1/320. The BIO photodiode receives the light that is reflected off the object and converts it to a current. The sensitivity of the proximity stage is also programmable by choosing from eight different integration times. It is insensitive to ambient light, filtering out the DC component of light and even compensating for strong sunlight.

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The application-specific integrated circuit, or ASIC, includes an LED driver, I^2C bus interface, amplifier, integrated analog to digital converter, oscillator, and Vishay's "secret sauce" signal processor. For proximity, it converts the current from the photodiode to a 12-bit or 16-bit digital data output value.

PIN CONNECTIONS

Fig. 3 shows the pin assignments of the VCNL3036.

The connections include:

- Pin 1 - V_{DD} to the power supply
- Pin 2 - SCL to the microcontroller
- Pin 3 - connects to ground
- Pin 4 - LED3 cathode (anode to the power supply)
- Pin 5 - LED2 cathode (anode to the power supply)
- Pin 6 - LED1 cathode (anode to the power supply)
- Pin 7 - INT to the microcontroller
- Pin 8 - SDA to the microcontroller

The power supply for the ASIC (V_{DD}) has a defined range from 2.5 V to 3.6 V. The external connected infrared emitter can also be within this range. It is best if V_{DD} is connected to a regulated power supply and the anode(s) of the external LED(s) are connected directly to the battery. This eliminates any influence of the high emitter current pulses on the V_{DD} supply line.

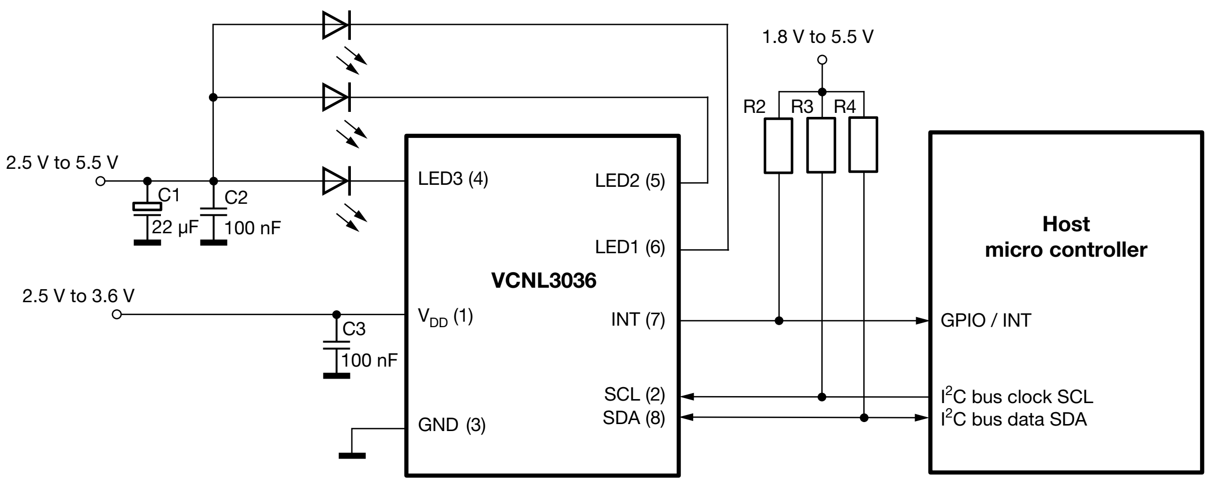

Fig. 3 - Circuitry With Two Separate Power Supply Sources

Three additional capacitors in the circuit are proposed for the following purposes: (1) the 100 nF capacitor near the V_{DD} pin is used for power supply noise rejection; (2) the 22 µF plus parallel 100 nF capacitors - connected to the common anode of the external IREDs / LEDs - are used to prevent the LED voltage from instantly dropping when an LED is switched on; and (3) 2.2 kΩ to 4.7 kΩ are recommended values for the pull-up resistor of the I^2C. The value of the pull-up resistor at the INT line could be 10 kΩ applied on the INT pin.

The separate anode voltage for the LEDs may even be connected up to 5.5 V.

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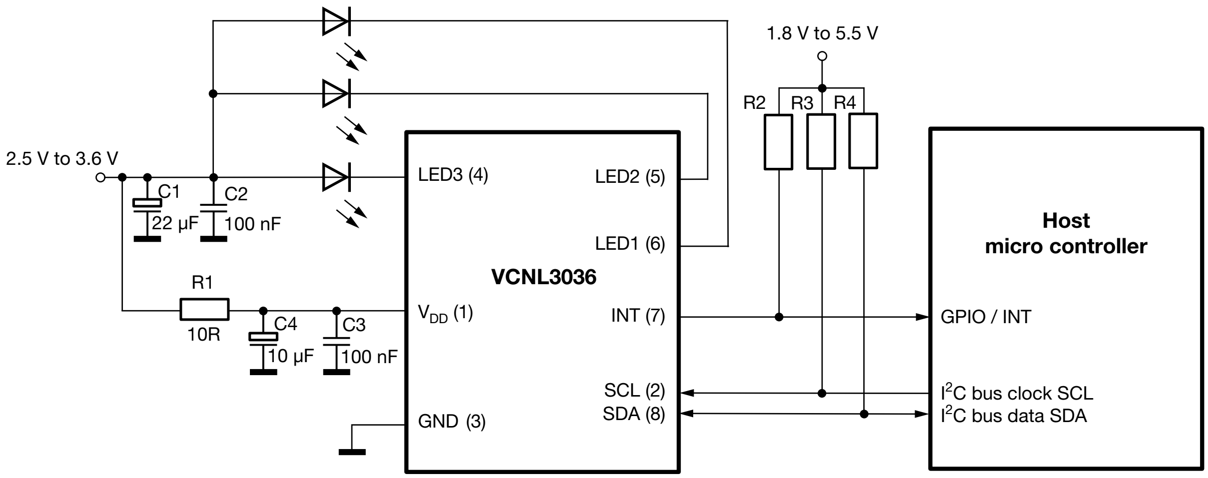

Fig. 4 - Circuitry With Just One Common Power Supply Source

For high currents of the LEDs and / or power supply close to the lower limit of 2.5 V, this R-C decoupling will prevent the V_{DD} voltage drop below a specified minimum.

The LEDs should come with a peak wavelength between 525 nm and 940 nm to match the sensitivity of the proximity photodiode.

Mechanical placement of the external LEDs depends on the application.

MECHANICAL DESIGN CONSIDERATIONS

The VCNL3036 is a dedicated BIO. The number and exact positioning of the external LEDs depends on the needs of the specific application.

The VCNL3036 does not require a mechanical barrier. LEDs placed close to the sensor will show crosstalk that will lead to an increase of so-called offset counts, but reflection from the cover may add even more. These total offset counts are fixed and can even be subtracted directly on-chip using the so-called “cancellation” register. Here the overall measured counts can be written in and are set to zero.

The only dimensions that the design engineer needs to consider are the distance from the top surface of the sensor to the outside surface of the window, and the size of the window. These dimensions will determine the size of the detection zone.

The sensitivity of the photodiode shows an angle of half sensitivity of about ± 55°.

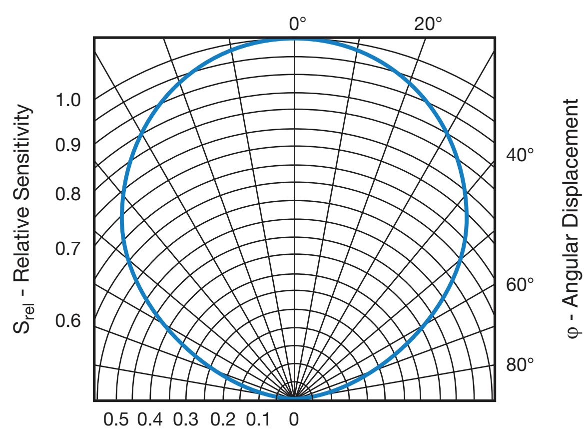

Fig. 5 - Angle of Half Sensitivity of the Photodiode

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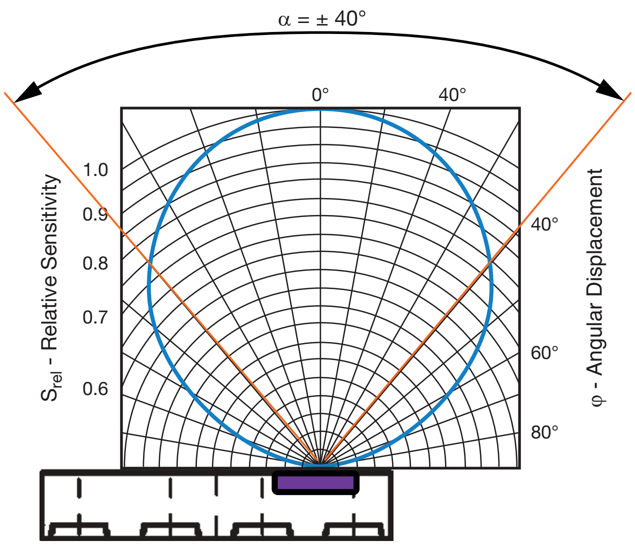

Fig. 6 - Proposed Angle of Relative Radiant Sensitivity

To achieve a good light response, the diameter of the hole within the cover glass should not be too small. An angle of ± 40° will be sufficient in most applications. The package drawing shows the position of the photosensitive area. The 40° lines should be set at the sides of the opening. The following are dimensions for the distance from the top surface of the sensor to the outside surface of the glass (a) and the width of the window (d).

For a single round hole, the diameter should be at least wide enough so that the opening can freely look through; so, about 1.2 mm if the cover is directly on top of the sensor: a = 0 mm.

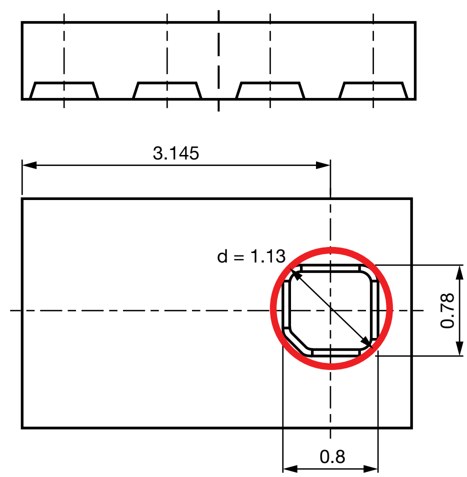

Fig. 7 - Light Hole Diameter
(in millimeters)

The diameter needs to be increased with the distance between the sensor and cover glass according to the following calculation:

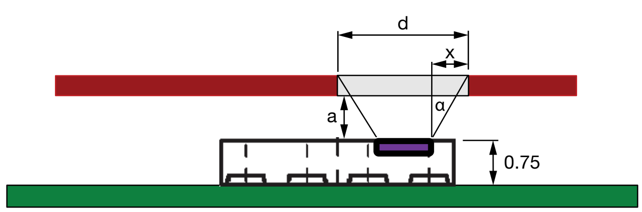

Fig. 8 - Window Dimensions for One Hole (in millimeters)

The width calculation for distances from 0 mm to 2 mm results in:

a = 0.0 mm→ x = 0.00 mm→ d = 1.2 mm + 0.00 mm= 1.20 mm
a = 0.5 mm→ x = 0.42 mm→ d = 1.2 mm + 0.84 mm= 2.04 mm
a = 1.0 mm→ x = 0.84 mm→ d = 1.2 mm + 1.68 mm= 2.88 mm
a = 1.5 mm→ x = 1.28 mm→ d = 1.2 mm + 2.56 mm= 3.76 mm
a = 2.0 mm→ x = 1.68 mm→ d = 1.2 mm + 3.36 mm= 4.56 mm

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PROXIMITY SENSOR

The main DC light sources found in the environment are sunlight and tungsten (incandescent) bulbs. These kinds of disturbance sources will cause a DC current in the detector inside the sensor, which in turn will produce noise in the receiver circuit. The negative influence of this DC light can be reduced by optical filtering, but is reduced much more efficiently by a so-called DC kill function. The proximity photodiode shows its best sensitivity at about 850 nm, as shown in Fig. 9.

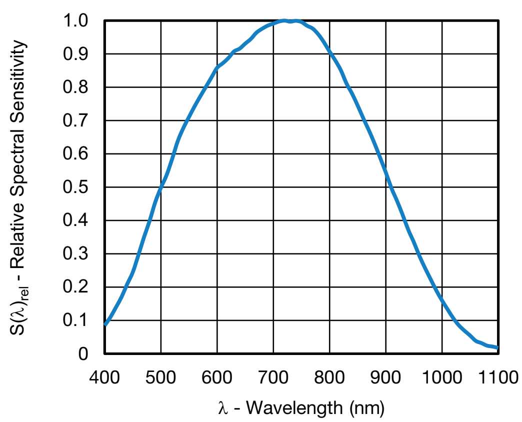

Fig. 9 - Normalized Spectral Response

The proximity sensor (PS) uses a short pulse signal of about 50 μs (PS_IT = 1T) up to 400 μs (PS_IT = 8T). The on / off duty ratio setting now defines which repetition rate to be used, which can be programmed from 1/40 up to 1/320.

In addition to DC light source noise, there is some reflection of the infrared emitted light off the surfaces of the components surrounding the VCNL3036. The distance to the cover, proximity of surrounding components, tolerances of the sensor, defined infrared emitter current, ambient temperature, and type of window material used all contribute to this reflection. The result of the reflection and DC noise is the production of an output current on the proximity photodiode. This current is converted into a count called the offset count.

In addition to the offset count, there could also be a small noise floor during the proximity measurement, which comes from the DC light suppression circuitry. This noise is typically just one or two counts. Only with light sources with strong infrared content could it be in the range from ± 5 counts to ± 10 counts.

The application should “ignore” this offset and small noise floor by subtracting them from the total proximity readings. The VCNL3036 offers a subtraction feature that automatically does this: PS_CANC. During the development of the end product, this offset count is evaluated and may be written into register 5: PS_CANC_L/M. Now the proximity output data will just show the subtraction result of proximity counts - offset counts.

Results most often do not need to be averaged. If an object with very low reflectivity or at longer range needs to be detected, the sensor provides a register where you can define the number of consecutive measurements that the signal must exceed before producing an interrupt. This provides stable results without requiring averaging.

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PROXIMITY CURRENT CONSUMPTION

The VCNL3036 offers a shutdown mode. The default value after start-up has it disabled.

The VCNL3036's embedded LED driver drives the external IRED(s) with a pulsed duty cycle. The IRED on / off duty ratio is programmable by an I²C command at register PS_Duty. Depending on this pulse / pause ratio, the overall proximity current consumption can be calculated. When a higher measurement speed or faster response time is needed, PS_Duty may be selected to a maximum value of 1/40, which means one measurement will be made every 2 ms, but this will then also lead to the highest current consumption:

PS_Duty = 1/40: peak IRED current = 100 mA,
averaged current consumption is 100 mA/40 = 2.5 mA.

For proximity measurements executed just every 40 ms:
PS_Duty = 1/320 peak IRED current = 100 mA,
averaged current consumption is 100 mA/320 = 0.3125 mA.

The above is always valid for the normal pulse width of T = 1T = 50 μs, as well as for 2T, 4T, 8T, and all others in between. These pulse lengths are always doubled, resulting in 400 μs for 8T, but the repetition time is also doubled, ending in a period time of about 128 ms.

An extremely power-efficient way to execute proximity measurements is to apply a PS active force mode (register: PS_CONF3, command: PS_AF = 1).

If only a single proximity measurement needs to be done, PS_AF is set to "1" and then PS_SD = 0 = active. Setting PS_Trig = 1 will then execute just one single measurement.

In this mode, only the I²C interface is active. In most consumer electronic applications, the sensor will spend the majority of time in sleep mode; it only needs to be woken up for a proximity or light measurement. In standby mode the power consumption is about 0.2 μA.

The pulse for proximity measurement looks to have a higher landing / step. This second trap is for smooth switch-off of the LED and is executed with very low IRED current. The pulse length in total is 200 μs. Amplitude of that first half is dependent on the IRED current. The higher this current is programmed, the higher that pulse amplitude will be. Taking a scope picture at IR_Cathode (pin 5) will look like the graphs shown in Fig. 10 and Fig. 11. The IRED on-time depends on the programmed proximity integration time, followed by a short switch-off time of about 5 μs.

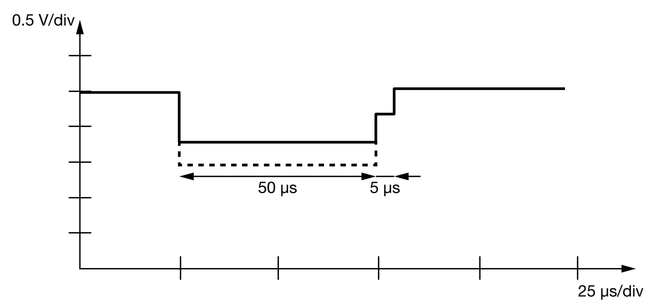

Fig. 10 - Proximity IRED Pulse for 1T

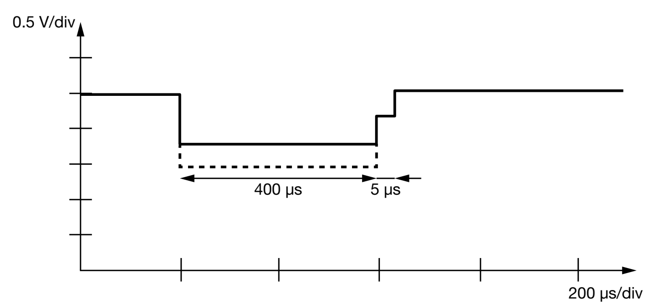

Fig. 11 - Proximity IRED Pulse for 8T

INITIALIZATION AND I²C TIMINGS

The VCNL3036 contains fifteen 16-bit command codes for operation control, parameter setup, and results buffering. All registers are accessible via I²C communication. The built-in I²C interface is compatible with the standard and high speed I²C modes. The I²C H-level voltage range is from 1.7 V to 5.5 V.

There are only five registers out of the fifteen that typically need to be defined:

1. LED_I = 50 mA to 200 mA (LED current)
   REGISTER PS_MS #04 [0x04_H]
2. LED_I_LOW = 1 (1/10 of normal current)
   PS_CONF3 #04 [0x04_L]
3. PS_Duty = 1/40 to 1/320 (proximity duty ratio),
   PS_IT (proximity integration time = pulse length),
   PS_PERS (number of consecutive measurements above / below threshold), and PS_SD (PS power_on)
   REGISTER PS_CONF1 #03 [0x03h]
4. and 5. Definition of the threshold value from the number of counts the detection of an object should be signaled.
   Proximity TOP Threshold REGISTER
   PS_THDL_L #06 [0x06h] for the low byte and
   PS_THDL_H #07 [0x07h] for the high byte

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To define the emitter current, as well as the integration time (length of the proximity pulsing), evaluation tests should be performed using the least reflective material at the maximum distance specified.

Fig. 12 shows the typical digital counts output versus distance that are seen using the VSMY2940 as the emitter placed about 20 mm away from the sensor and operated with max. LED current of 200 mA and highest proximity integration time of 400 µs. Here the so-called "two step" mode is used, and with PS_NS = 0 a four times higher gain is programmed. The reflective reference medium is the Kodak Gray card. This card shows approximately 18 % reflectivity at 940 nm.

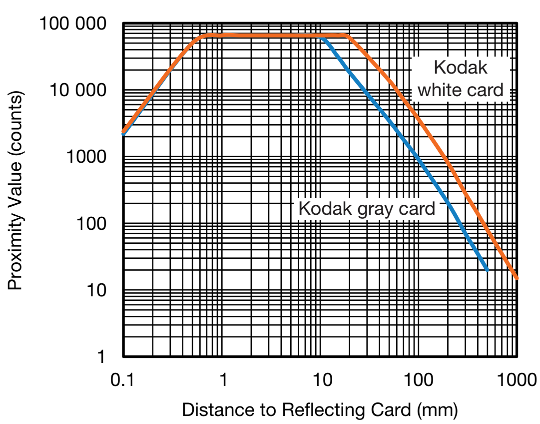

Fig. 12 - Proximity Value vs. Distance for 8T and 200 mA

This diagram shows the possible detection counts with a short pulse of 400 µs and the two step mode. Another mode is the "single mode". This may show an advantage if the sensor also needs to be used under strong sunlight conditions and for long distances, where only few detection counts will be seen. This single mode is available with two different sensitivities. Single mode x 1 delivers higher gain and the best compensation for disturbing light sources and for strong sunlight. In addition, the compensation current can be modified with PS_SC-CUR in four possible steps from "typical" up to eight times this typical current.

To define for this "sunlight cancellation", the bit PS_SC_EN has to be set. The bit PS_SP also enhances the sunlight cancellation capability, typically by 50 %. The bit PS_SPO defines the counts that should be presented if strong sunlight requires protection, either zero counts or max. counts, 65 535 in 16-bit mode.

In order to reach the high reflection counts of the Kodak Gray card, one has to define the proximity range to 16 bits, otherwise the 12-bit range would just lead to 4095 counts. This is possible to select with: PS_HD = 1 within PS_CONF2 byte of command code #3.

The duty time (PS_Duty) is defined as the repetition rate or the number of proximity measurements per second (speed of proximity measurements). This is possible between 2 ms (about 500 measurements/s) by programming PS_Duty with 1/40 and 16 ms (about 62 measurements/s) with programming PS_Duty with 1/320.

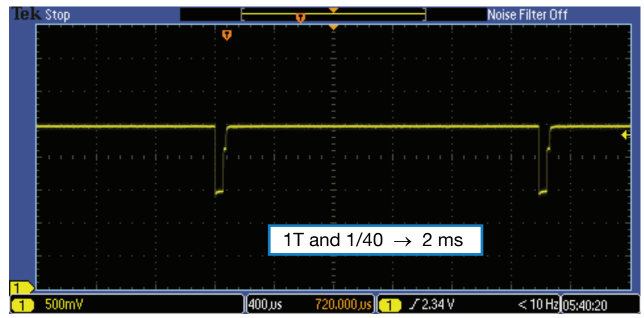

Fig. 13 - Proximity Measurements With PS_Duty = 1/40

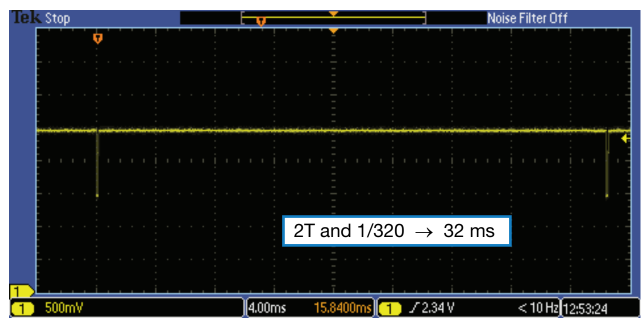

Fig. 14 - Proximity Measurements With PS_Duty = 1/320

This duty cycle also determines how fast the application reacts when an object appears in, or is removed from, the proximity zone.

Reaction time is also determined by the number of counts that must be exceeded before an interrupt is set. This is possible to define with proximity persist: PS_PERS. Possible values are from 1 to 4.

To define all these register values, an evaluation test should be performed. These tests can be made just using the VCNL3036 sensor board together with the SensorXplorer™. To request for VCNL3036 sensor board and SensorXplorer, please contact sensortechsupport@vishay.com.

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Timing

For an I²C bus operating at 100 kHz, to write or read an 8-bit byte, plus start (or stop) and bit acknowledgement, takes 100 µs. Together with the slave address byte and the 8-bit command code byte, plus the 16-bit data, this results in a total of 400 µs. When the device is powered on, the initialization with just these five registers needs 5 x 4 bytes (slave address, command register, and 16-bit data) for a total of 20 bytes. So, 20 x 100 µs = 2000 µs = 2 ms.

Send Byte → Write Command to VCNL3036

1	7	1	1	8	1	8	1	8	1	1
S	Slave Address	Wr	A	Command Code	A	Data Byte Low	A	Data Byte High	A	P

The read-out of 16-bit data would take a total of five bytes (slave address, command code, slave address with read bit set) and 16-bit data sent from the VCNL3036. So, 500 µs:

Receive Byte → Read Data from VCNL3036

1	7	1	1	8	1	1	7	1	1	8	1	8	1	1
S	Slave Address	Wr	A	Command Code	A	S	Slave Address	Rd	A	Data Byte Low	A	Data Byte High	A	P

Power Up

The release of the internal reset, the start of the oscillator, and the signal processor need **2.5 ms**

Initialize Registers

Write to three registers**1200 µs**

- LED current
- Proximity duty ratio
- Proximity interrupt TOP threshold

Once the device is powered on and the VCNL3036 is initialized, a proximity measurement can be taken.

Asking for one forced proximity measurement	**400 µs**
For (active forced, PS_IT = 8T)	
Time to trigger [0.5 x PS_IT]	**200 µs**
DC-kill ambient light [3 x PS_IT]	**1200 µs**
Proximity measurement [1 x PS_IT]	**400 µs**
IRED shutdown [1 x PS_IT]	**400 µs**
Read out of the proximity data	**500 µs**
total:	**3100 µs**

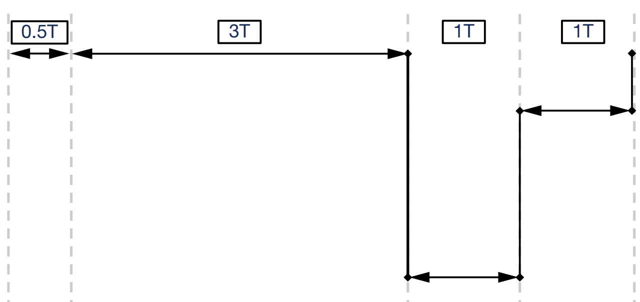

Fig. 15 - Timing Specification for Active Forced Mode

Interrupt

The VCNL3036 features a very intelligent interrupt function. The interrupt function enables the sensor to work independently until a predefined proximity event or threshold occurs. It then sets an interrupt, which requires the microcontroller to awaken. This can help you reduce your software effort, and reduces power consumption by eliminating polling communication traffic between the sensor and microcontroller.

The interrupt pin, pin 7, of the VCNL3036 should be connected to a dedicated GPIO of the controller. A pull-up resistor is added to the same power supply that the controller is connected to. This INT pull-up resistor may be in the range of 8.2 kΩ to 100 kΩ.

The events that can generate an interrupt include:

- A lower and an upper threshold for the proximity value can be defined. If the proximity value falls below the lower limit or exceeds the upper limit, an interrupt event will be generated. In this case, an interrupt flag bit in the read-out register 0x0D will be set and the interrupt pad of the VCNL will be pulled to low by an open drain pull-down circuit. In order to eliminate false triggering of the interrupt by noise or disturbances, it is possible to define the number of consecutive measurements that have to occur before the interrupt is triggered

Beside this "normal" interrupt mode, an automatic mode is also available, which is called the logic output mode.

This mode automatically pulls the interrupt pin low when an object exceeds the programmed upper threshold and also resets it if the lower threshold is exceeded. So no actions from the controller are needed if, for example, a smartphone is held close to the ear but is quickly taken away (e.g. for a short look at the display).

Application Example

The following example will demonstrate the ease of using the VCNL3036 sensor. The following example has been tested with VCNL3036 sensor board and SensorXplorer. To request for VCNL3036 sensor board and SensorXplorer, please contact sensortechsupport@vishay.com.

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Offset

During development, the application-specific offset counts for the sensor were determined. As previously mentioned, the offset count is affected by the components surrounding the VCNL3036, the window or cover being used, the distance from the sensor to the cover, and emitter intensity, which is controlled by the forward current.

In the following example, with that small plastic cover over the sensor, using the green LED, and with the LED current set to 5 mA, the offset counts are about 300 counts (Fig. 22). Offset counts vary by application and can be anywhere from 0 counts to several hundred counts. It is important to note that the offset count may change slightly over time due to, for example, the window becoming scratched or dirty, or being exposed to high temperature changes. If possible, the offset value should occasionally be checked and, if necessary, modified.

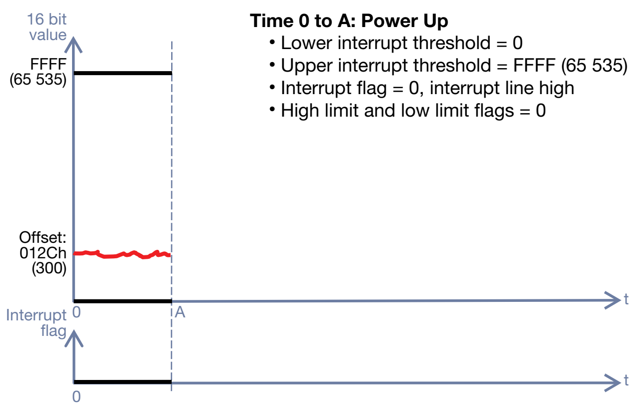

Fig. 16

Power Up

As mentioned previously, there are four variables for proximity measurement that need to be set in the register when the sensor is powered up: the emitter current, the number of occurrences that must exceed a threshold to generate an interrupt, the threshold values, and the number of proximity measurements per second.

The sensor should detect a finger placed directly on the small plastic cover above the sensor. Development testing determined that a current of just 5 mA, together with a proximity integration time of PS_IT = 2T, produces adequate counts for detection and heart rate measurement. The proximity measurement rate is set so that about 25 measurements are done within a second and the number of occurrences to trigger an interrupt is set to four. Based on development testing, with a finger directly on that small cover, the resulting total count is more than 1000. This will be used as the upper threshold (high threshold).

For some applications it would be typical to initially set this top threshold and a lower threshold (bottom threshold). This is needed to indicate the absence of the finger from the sensor. The measured counts without any additional object close by will be around this offset count value, always below the lower threshold value, as shown in Fig. 17.

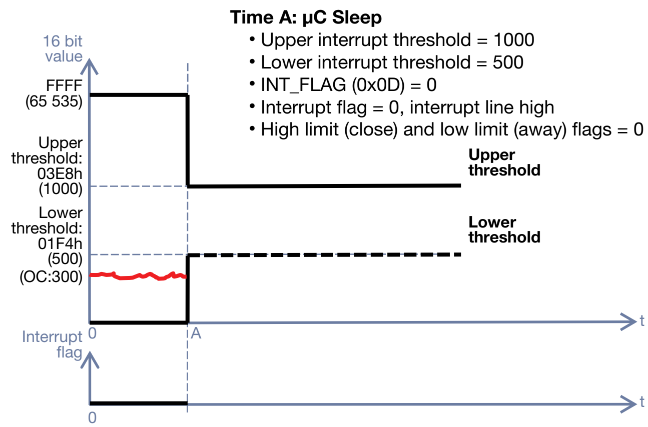

Fig. 17

By setting the number of occurences before generating an interrupt to four, a single proximity value above or below the thresholds will have no effect, as shown in Fig. 18.

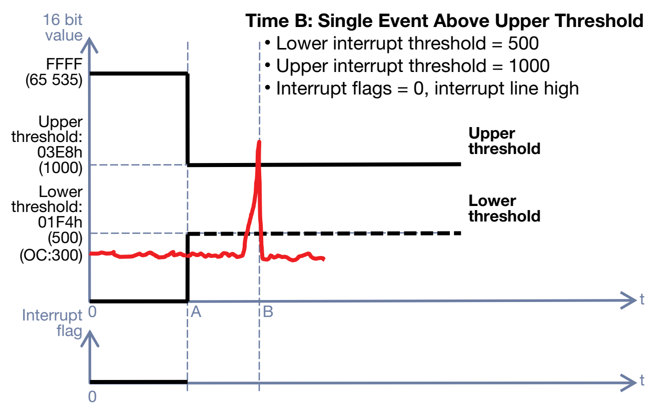

Fig. 18

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For a “wearable” application, a hand / finger coming closer may be detected, and only then will the proximity rate increased to get more precise heart rate values.

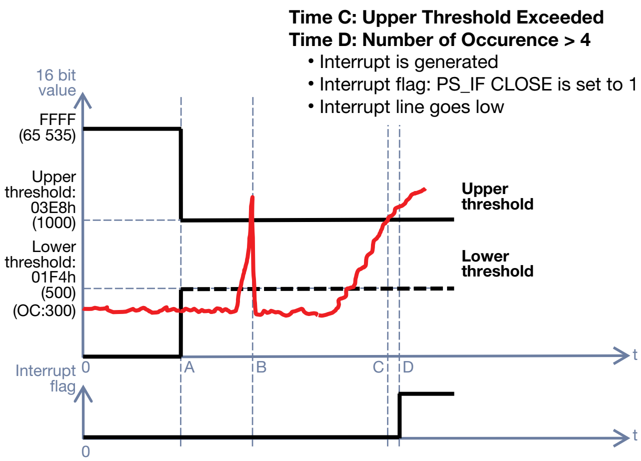

Fig. 19

In some applications, the bottom threshold will also be programmed and will wait for an interrupt signal. A lower threshold will occur when the finger is away from the cover / sensor and the proximity measurement rate may be set to a slower speed again to save power.

For this example, the upper threshold will be set to 1000 counts. The lower threshold is set to 500 counts; a value that is higher than the offset but low enough to indicate the removal of the finger.

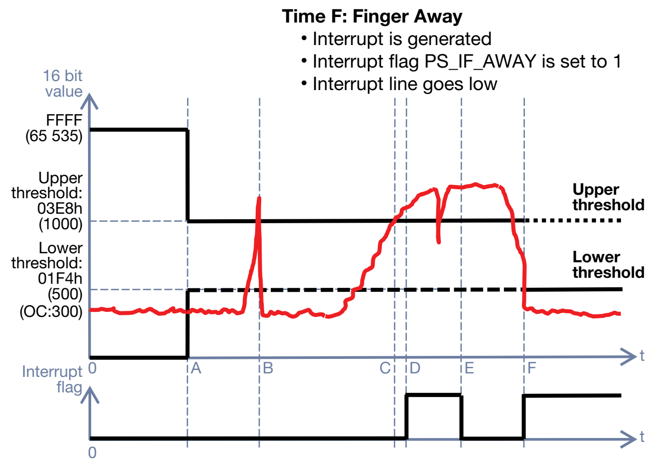

Fig. 20

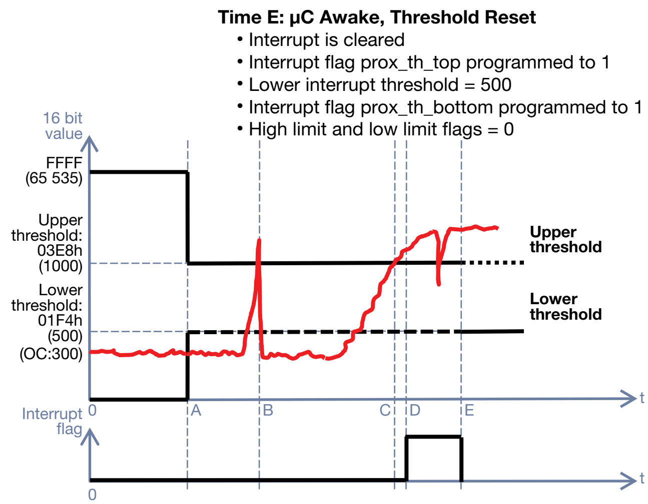

Fig. 21

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Some measurements and features are shown with the demo tool and demo software with the small, clear plastic cover being about 1 mm above the sensor.

1. Proximity set-up with 2T wide pulses, 5 mA LED current, and a duty cycle of 1/40, which results in about 167 measurements per second

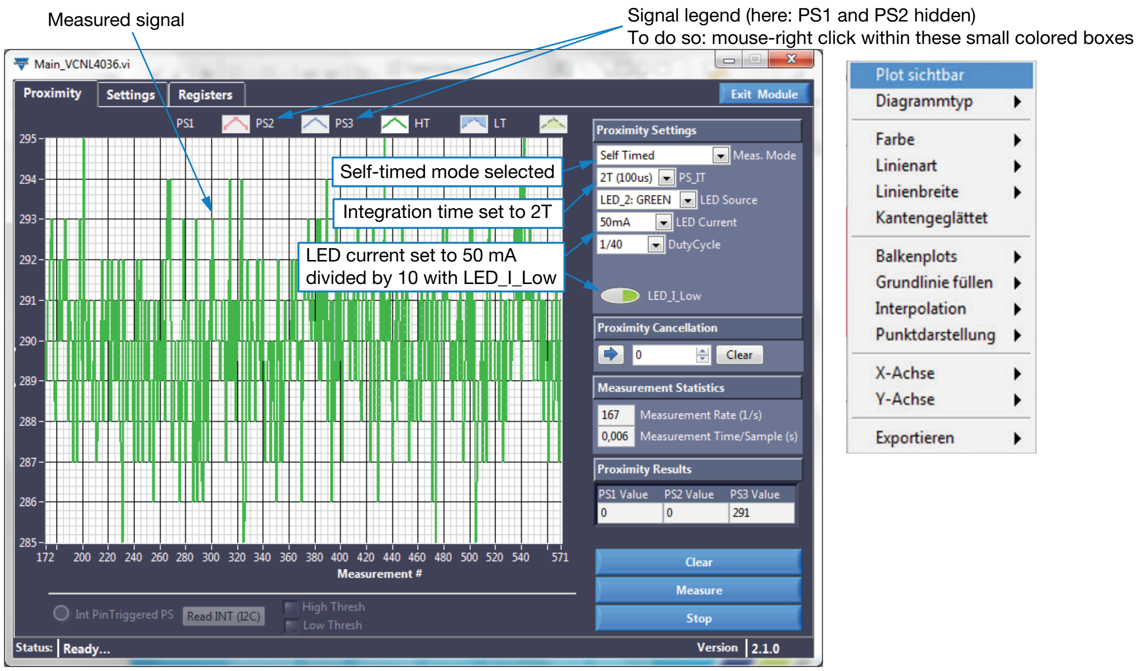

Fig. 22 - Screenshot of Initial Appearance of the VCNL3036 Demo Software

Modes of Proximity Operation:

- Single forced: pulses the selected LED once
- Self timed: pulses the selected LED with a defined duty cycle
- Continuous forced: pulses the selected LED continuously
- Multiplex mode: pulses all three LEDs

Remark:

Within multiplex mode, the duty cycle is fixed and as fast as indicated on page 19.

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2. If a finger is placed directly on the small plastic cover, the 300 offset counts increase to more than 1000 counts

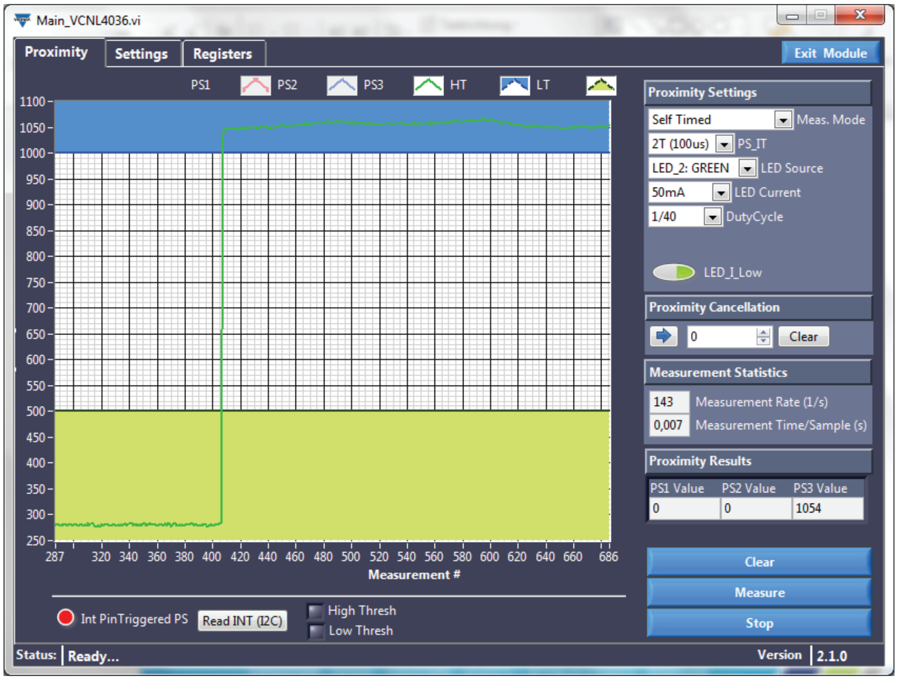

Fig. 23 - Upper and Lower Threshold Set and Finger Placed at Small Plastic Cover

3. Here the thresholds are programmed as 1000 for the upper and 500 for the lower. To see these, both "Show" buttons are activated. The presence of an object should only be recognized when four consecutive measurements are above that threshold

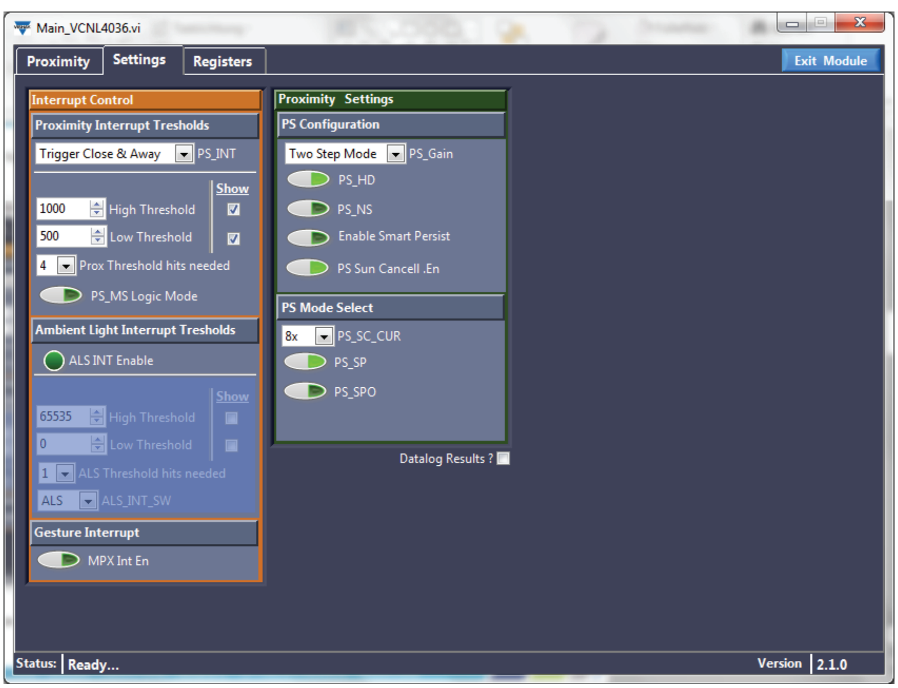

Fig. 24 - Upper and Lower Threshold Set and Four Hits Programmed

APPLICATION NOTE

Designing the VCNL3036 Into an Application

4. Just one or two measurements above the threshold will not activate the interrupt

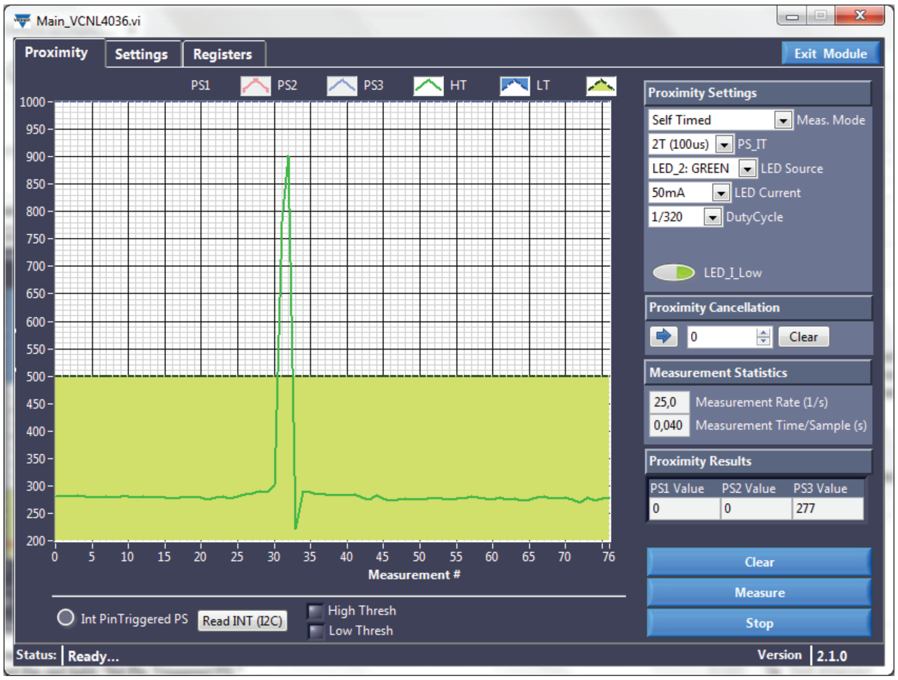

Fig. 25 - Just One Measurement Does Not Cause an Interrupt

5. With more than four measurements above the threshold, however, the interrupt is pulled low, as indicated by the red LED on the demo board and the red light: “Int Pin Triggered PS”

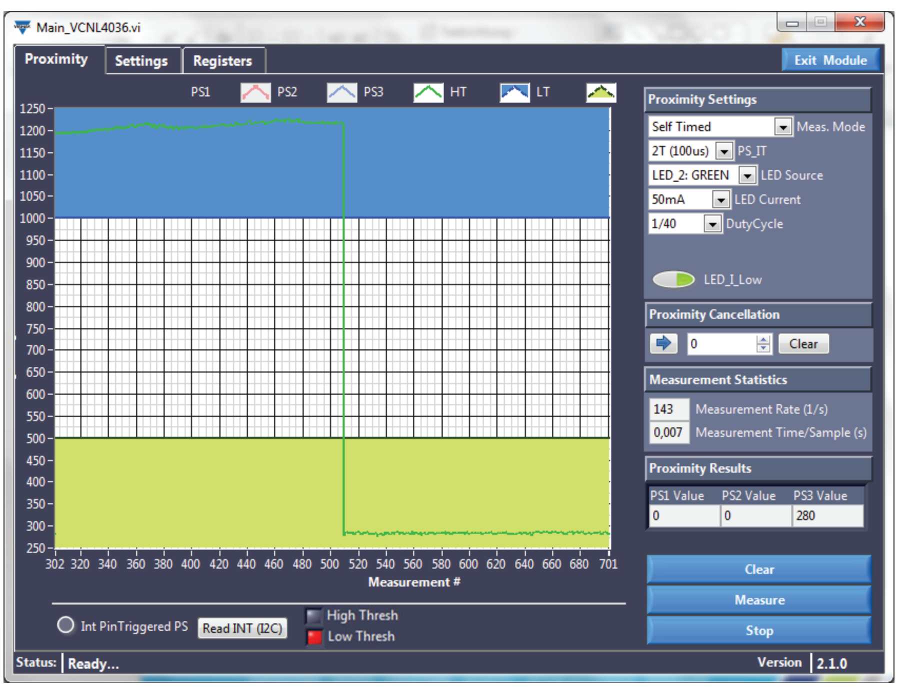

Fig. 26 - Finger Removed Again, Measured Counts Fall Back to the 300 Offset Counts

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6. The cancellation feature is used below. The “before seen” offset counts are subtracted internally. To do so, the value of 300 is entered for register number 05 = Prox_Cancellation

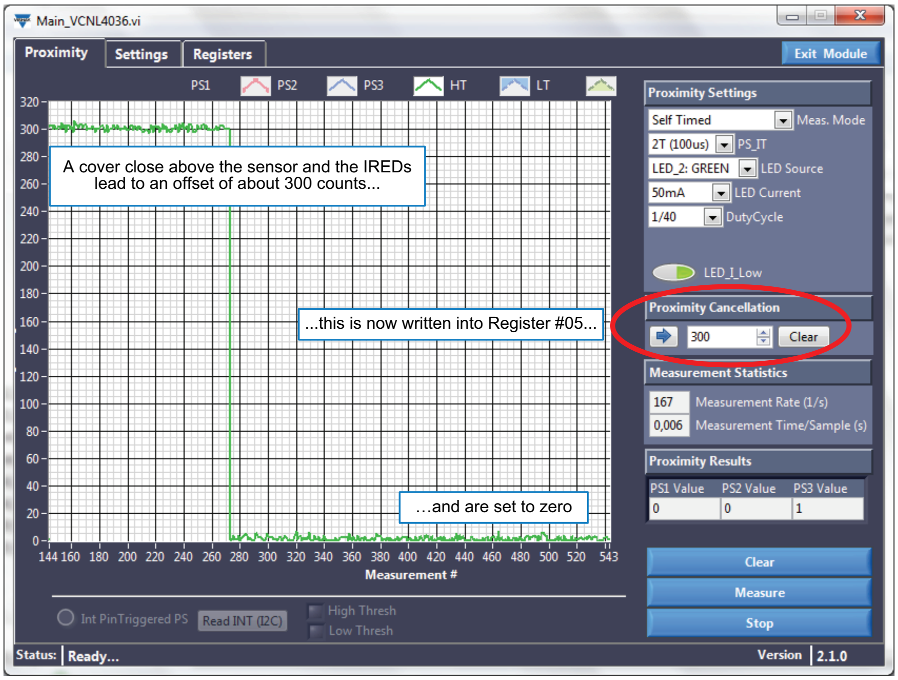

Fig. 27 - Proximity Cancellation Feature

7. The “before seen” measured proximity result data of 300 is now subtracted, so zero counts appear. Also, the thresholds are now 300 counts lower. The higher threshold is 700 and the lower is just 10.

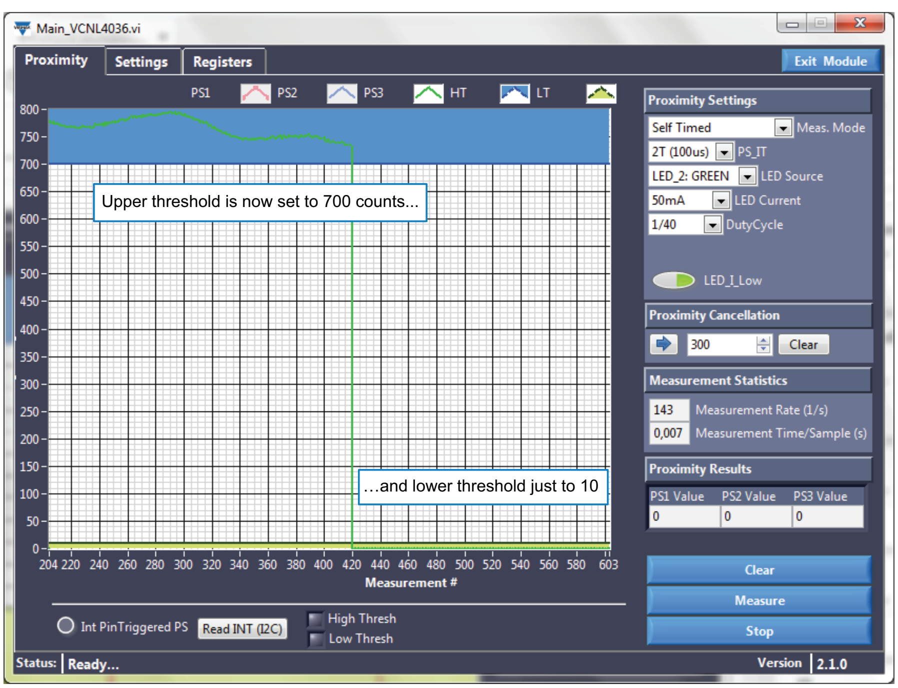

Fig. 28 - Proximity Cancellation Feature Active

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HEART RATE MEASUREMENT

The VCNL3036 combines a photodiode, an op-amp, a 16-bit A/D converter, and a signal and timing processor together with a programmable IRED / LED driver and connectivity for added external LEDs. The sensitivity of the photodiode allows for the detection of a wide spectra from low green (≤ 550 nm) to IR wavelengths (950 nm).

The VCNL3036 sensor board (Fig. 37) comes with the sensor itself, plus added external LEDs to fulfill all requests for accurate heart rate measurements. Allowing for the added VSMD66694 offers the possibility to measure with an external red LED and 940 nm IRED, plus a green LED placed nearby to also allow for measurement with this lower wavelength, which may show advantages.

Activating the desired LED / IRED is done with the bit "LED select".

The whole circuit diagram of the board is shown in Fig. 38.

To now do heart rate measurements, the demo software needs to be started and a finger placed on the small, clear plastic cover above the LEDs and sensor.

The needed emitter current may be as low as just 5 mA to 20 mA, so the bit "LED_I_LOW" should be set to divide the LED current (50 mA to 200 mA) by 10. For the red LED, 10 mA is enough for this tool to have no saturation due to the distance the cover is from the sensor and the high sensitivity of the detector for this wavelength.

The VCNL demo tool would show this AC signal = heart rate, as shown in Fig. 36. The calculation for beats per minute (BPM) is simply done by multiplying the time between two absolute "H" (high) peaks with 60. The time itself is given with the ratio between the total number of measurements between these two peaks and the available measurement rate (see Fig. 29).

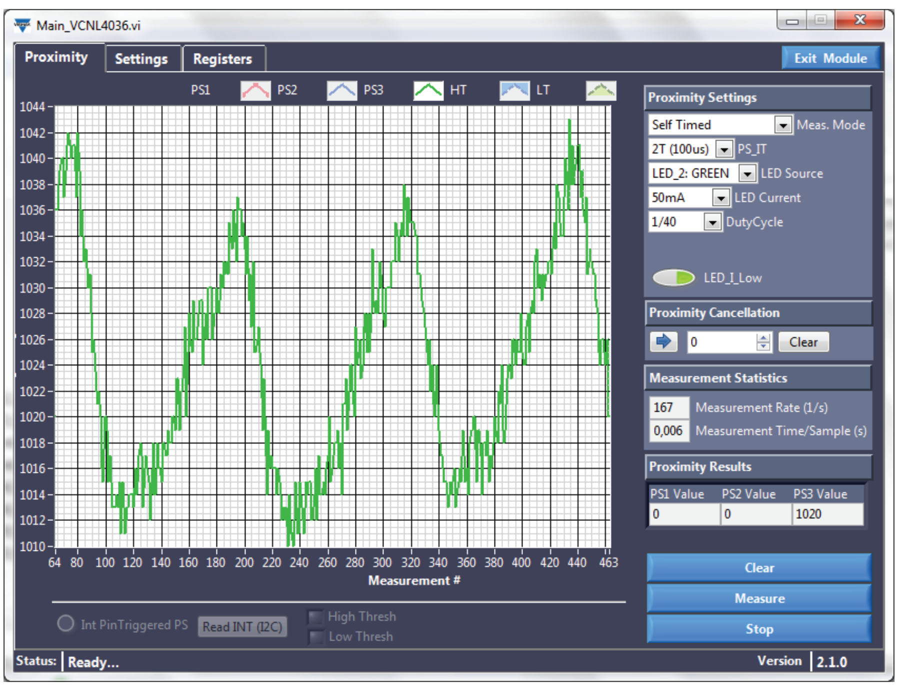

Fig. 29 - HRM Pulses Measured With the VCNL3036 Sensor Board

To see the exact measured data, one may just zoom for a proper period, having the mouse cursor within the window of the signal data and with the "left" tab zoom for just two maxima.

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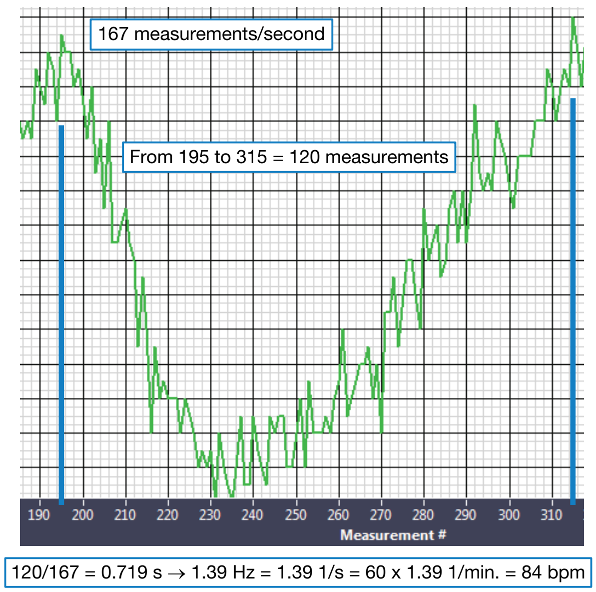

Fig. 30 - "Zoomed" Data

Exporting data to an Excel file is possible with just a right click within the data signal window. The window below will pop up:

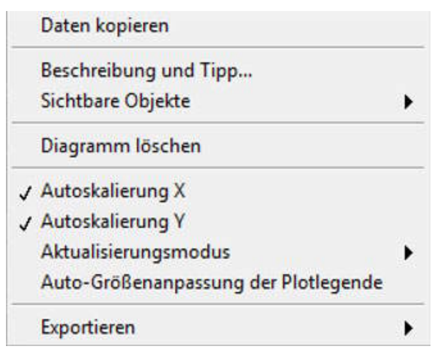

Fig. 31 - Copy Data to an Excel File

"Exportieren" leads to a second menu where the export to Excel function is provided, and when chosen, an Excel spreadsheet will be opened with the data in it, which just needs to be saved to the desired folder.

The dedicated algorithm now detects the seen maxima, and with the known measurement speed the BPM are calculated.

How this is possible to realize can be seen within the attached flow chart, as well as an Excel file Vishay provides upon request.

Most commonly a transmissive mode is used, where a sensor is placed at a finger or the earlobe. Two LEDs are used with different wavelengths and a very sensitive detector measures the changing absorbance at either infrared or visible wavelengths.

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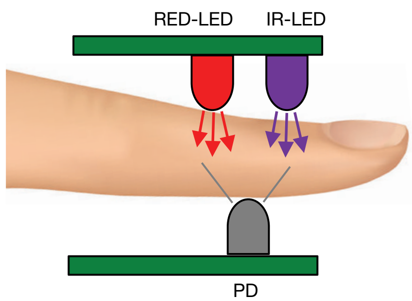

Fig. 32 - Sensing in Transmissive Mode

In addition to the transmissive mode, a reflective mode can also be used. Here the LEDs and the detector are located on the same side. A very well-designed light barrier is needed between the LEDs and detector.

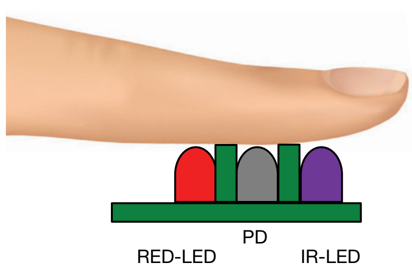

Fig. 33 - Sensing in Reflective Mode

The VCNL3036 digital sensor requires no additional light barriers, as its package serves this purpose quite well and the detector is not loaded with crosstalk directly from the LED chips.

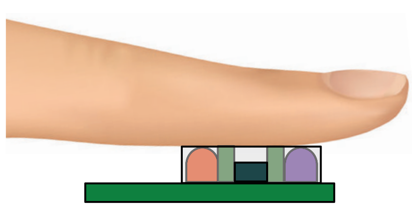

Fig. 34 - Sensing in Reflective Mode With the VCNL3036

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Within the VCNL3036 sensor board, the double-LED device VSMD66694 is placed close to the sensor. Here a red LED with a peak wavelength at 660 nm and a 940 nm IRED are packed together in a small 2 mm x 2 mm package.

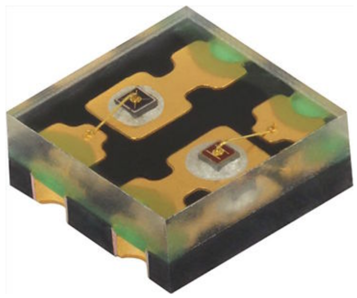

Fig. 35 - Double-LED Device: VSMD66694

The wavelengths optimal for this measurement may depend on where the HRM is being performed, such as at a finger or earlobe. The photodiode receives the non-absorbed reflected light, the heart rate related pulsing signal, together with a big portion of light reflecting from venous blood, non-pulsatile blood, and tissue plus bones.

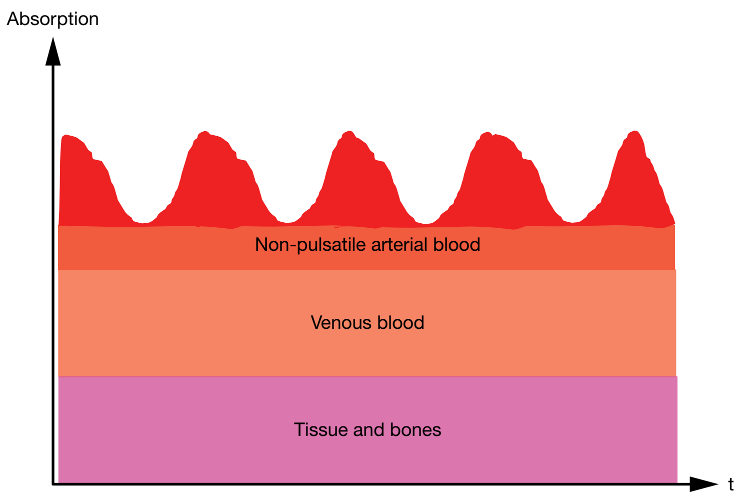

Fig. 36 - Heart Rate Pulsing and Other Reflected Light

Fig. 37 - VCNL3036 Sensor Board With Added External LEDs

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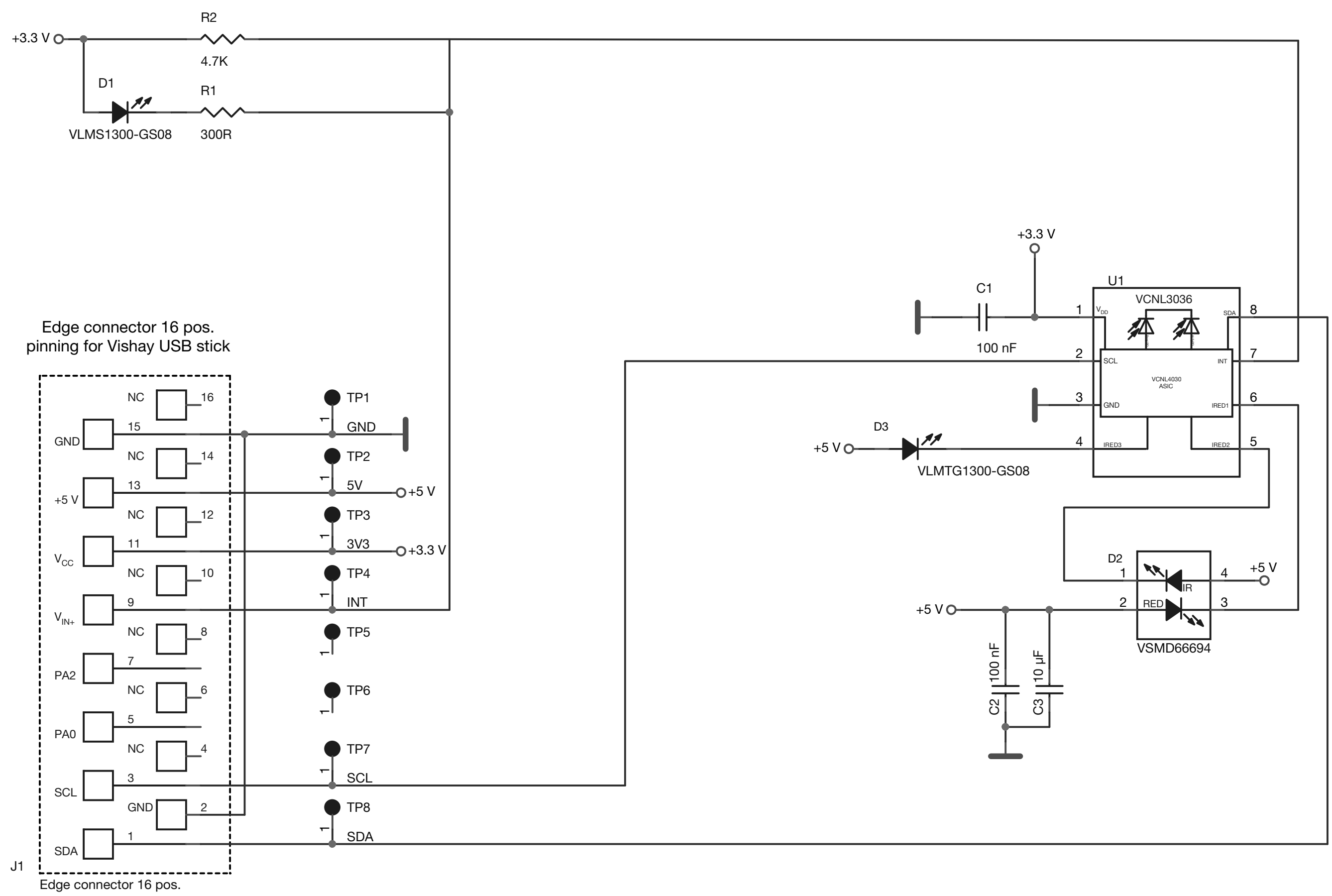

Fig. 38 - VCNL3036 Sensor Board Circuit Diagram

Note

- When using the VCNL3036 sensor board without the Vishay USB stick, additional pullup resistors (2.4 kΩ to 10 kΩ) on SDA and SCL are necessary

To request for VCNL3036 sensor board and SensorXplorer, please contact sensortechsupport@vishay.com.